

# Winter warming damage of sub- Arctic vegetation detected and monitored from space

Hans Tømmervik

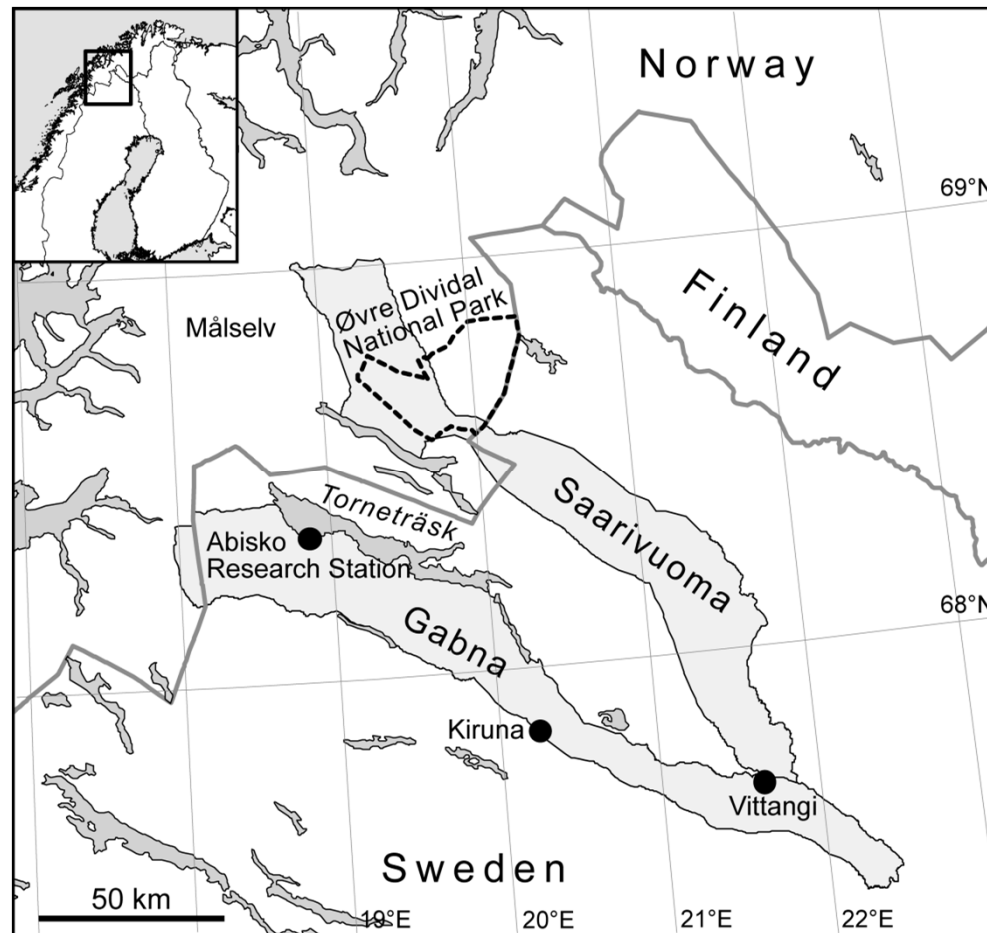
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Norwegian Institute for Nature  
Research - NINA

## **Detection of extensive damage to sub-Arctic vegetation caused by a short extreme winter warming event**

- Detection period: Spring-summer 2008
- Effects of a short extreme winter warming event in December 2007 and reduced snow fall the winter 2007-2008
- MODIS
- SPOT, IRS, LANDSAT

# Study area



# Reduced snow cover induce frost damage to the heaths

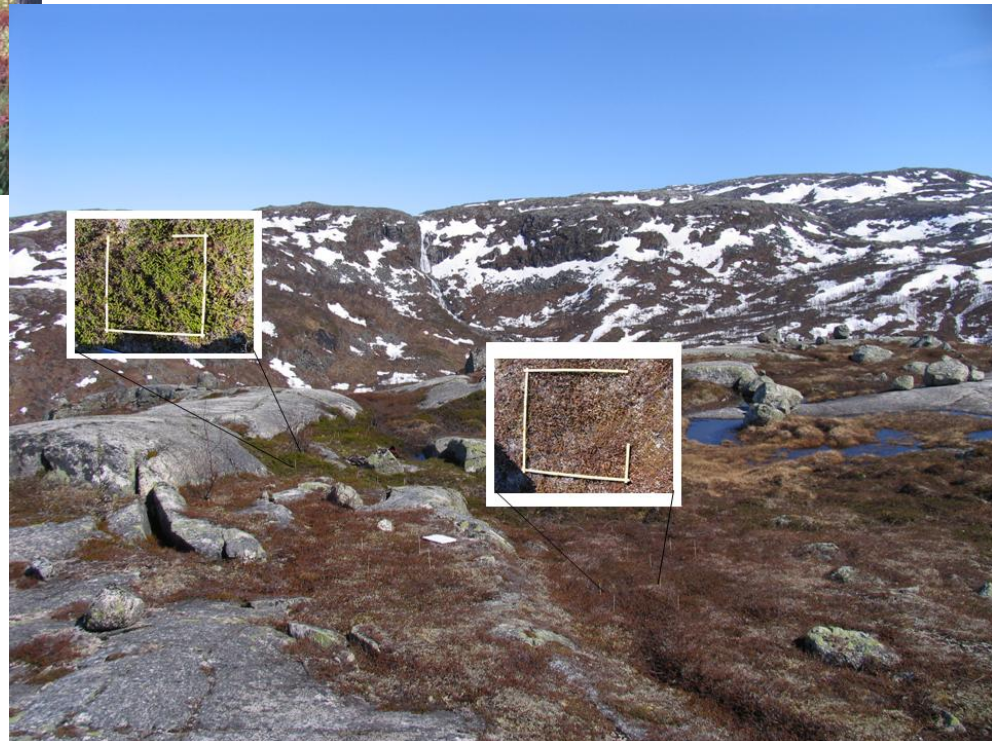


# Effects on *Empetrum hermaphroditum*



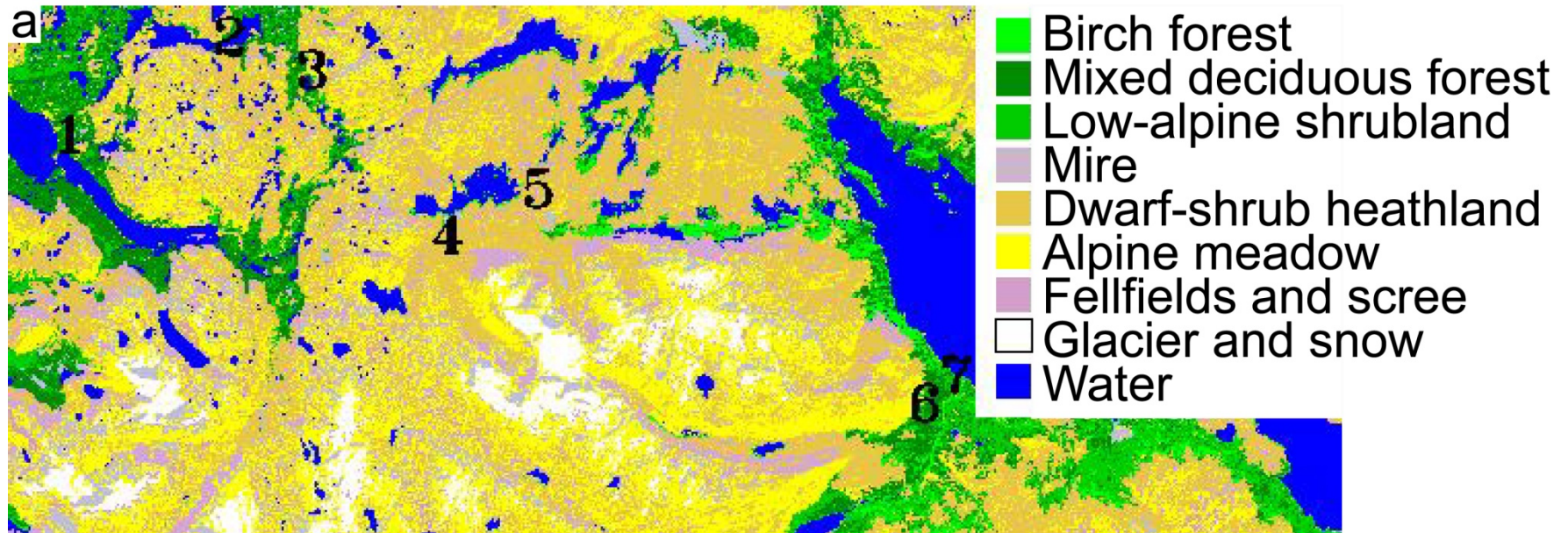
Clearly induced by  
climatic change

The area affected: >1400  
km<sup>2</sup>

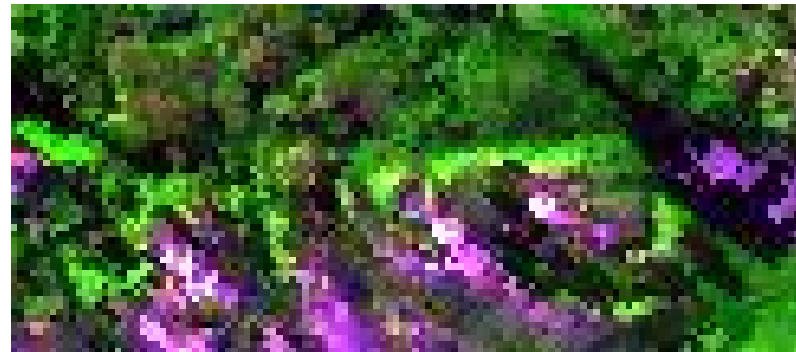
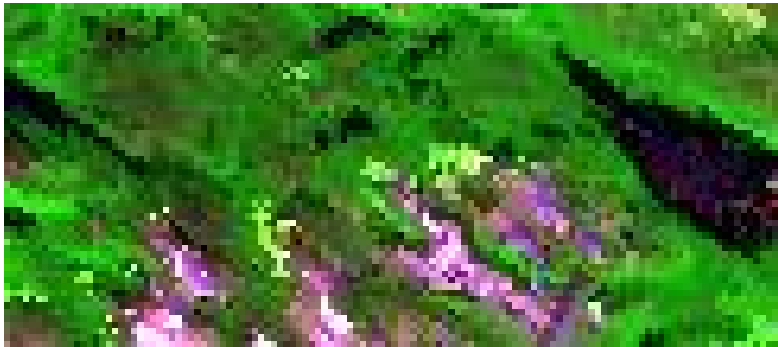




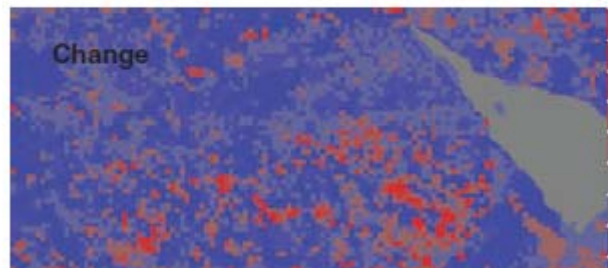
# Vegetation map Abisko-Narvik



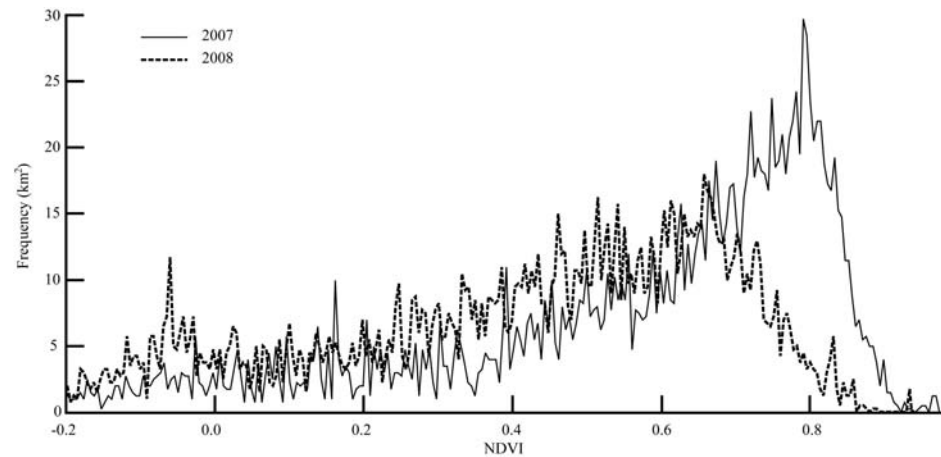
# MODIS 2007-2008



# Change detection MODIS



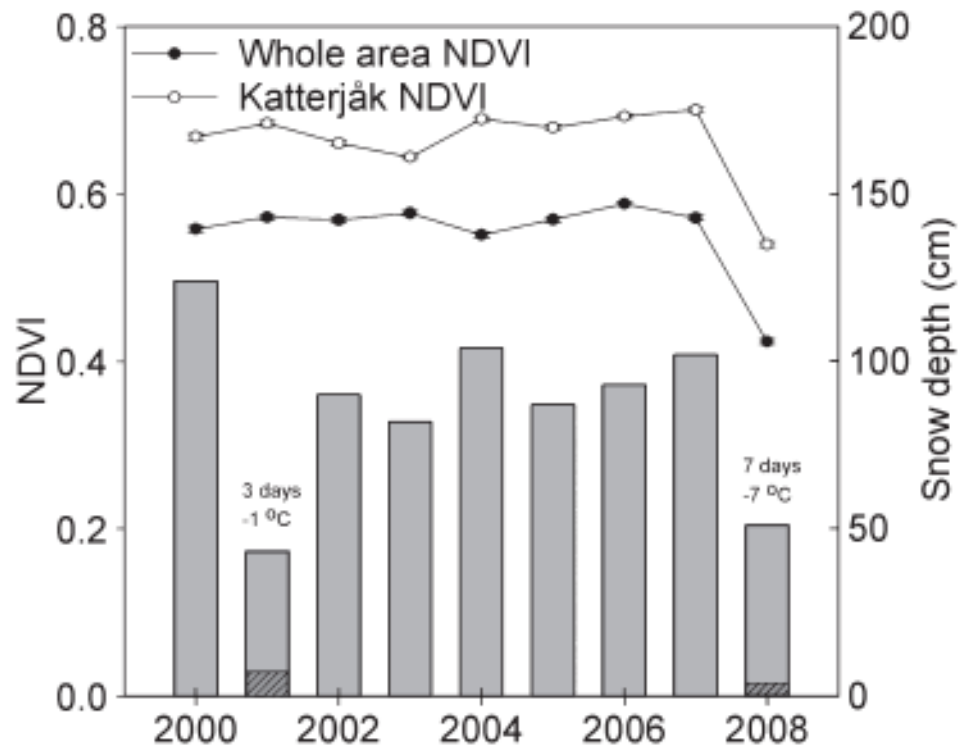
20 km



- Change (+5)
- Change (+4)
- Change (+3)
- Change (+2)
- Change (+1)
- No change
- Change (-1)
- Change (-2)
- Change (-3)
- Change (-4)
- Change (-5)



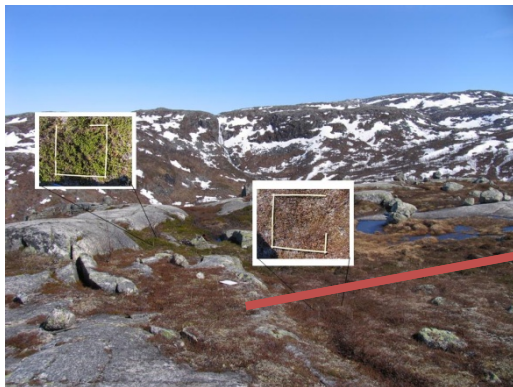
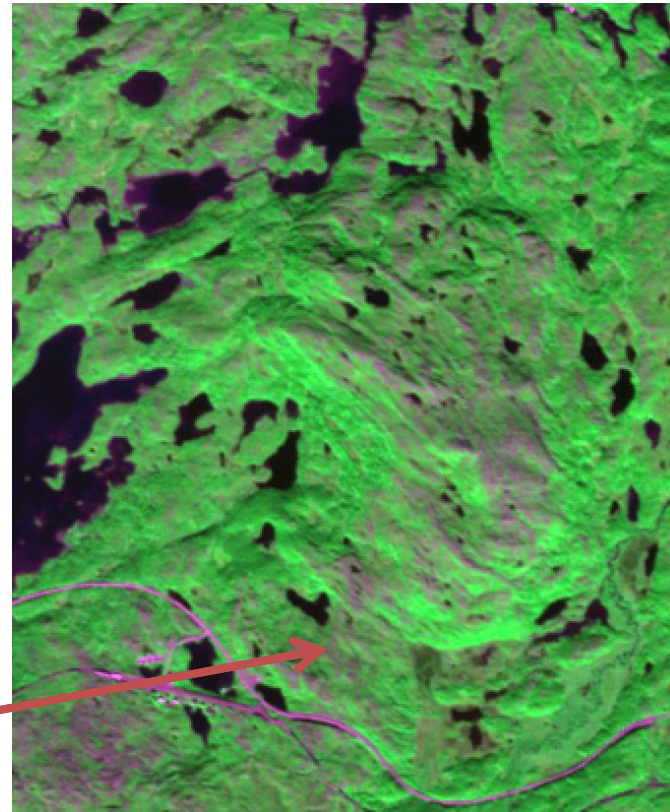
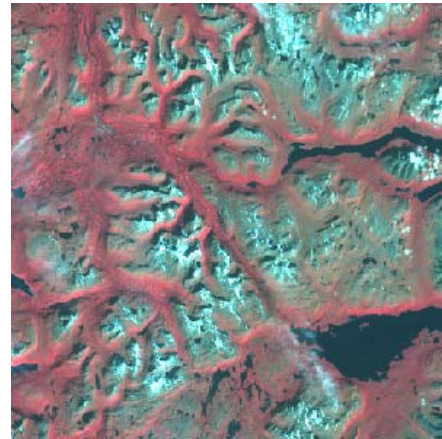
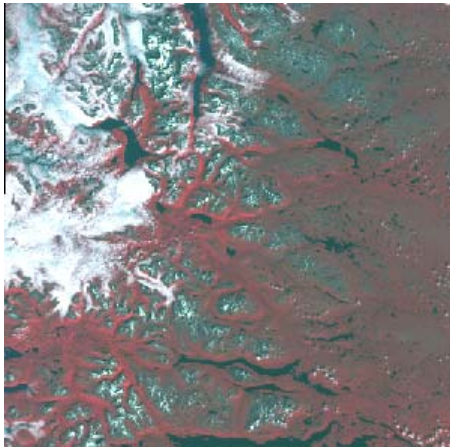
# Snow depth vs. NDVI (MODIS)



# SPOT and IRS

- IRS 2008

SPOT 2008



# Source:

**Journal of Ecology**



British Ecological Society

*Journal of Ecology*

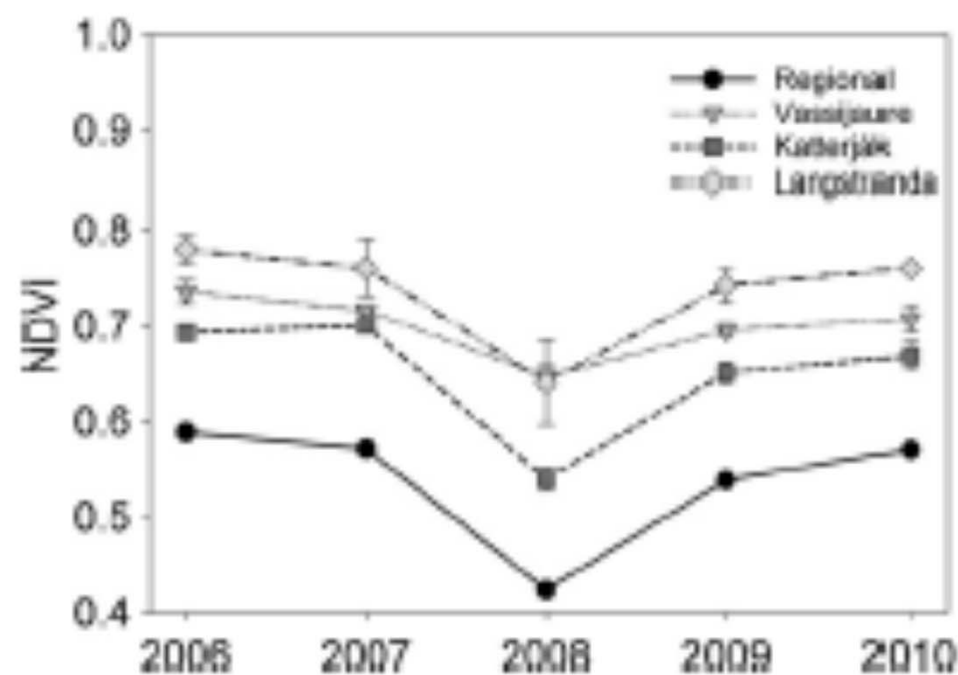
doi: 10.1111/j.1365-2745.2009.01554.x

## **Winter warming events damage sub-Arctic vegetation: consistent evidence from an experimental manipulation and a natural event**

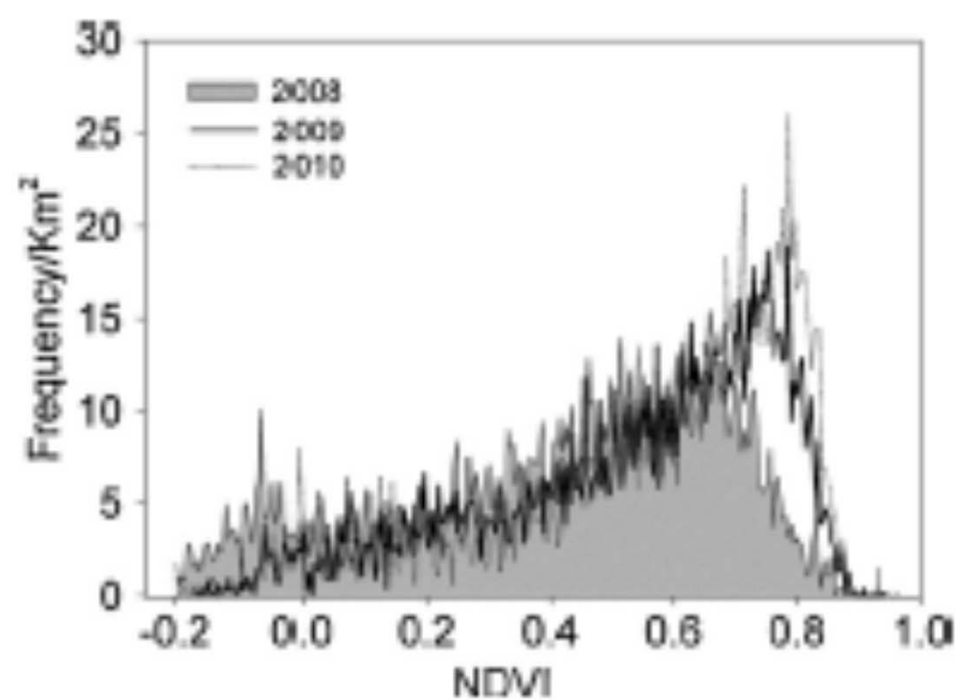
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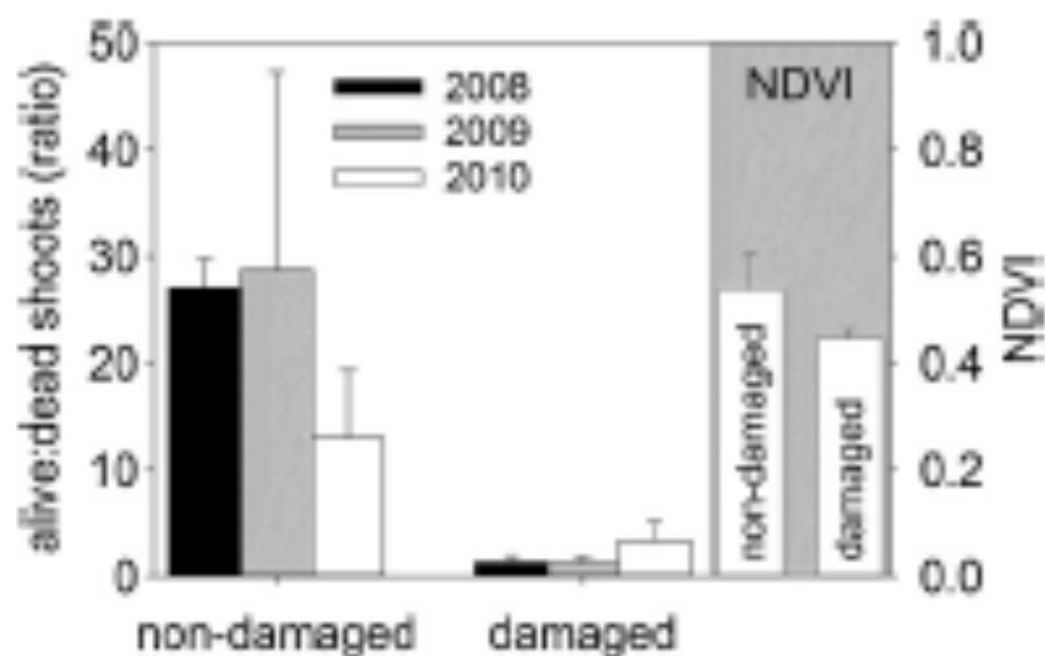


**Fig. 2.** Regional and local NDVI values in northern Scandinavia. The regional NDVI were from a 1425 km<sup>2</sup> area between the Norwegian coast (at Narvik 68° 25' N, 17° 33' E) to Abisko (68° 21' N, 18° 49' E Sweden). Vassijaure, Katterjåk and Langstranda were local sites in between where obvious vegetation damage was visible following an extreme winter warming event during December 2007. The 2007 and 2008 data were previously presented by Bokhorst et al. (2009). Error bars are SE, but can be smaller than dot size. The regional NDVI values are lower than the local sites because it includes large bodies of water reducing NDVI.



**Fig. 3.** NDVI value distribution in mid-July after the natural winter warming event of 2008 (in grey), and in the two following years across a 1425 km<sup>2</sup> area from the Norwegian coast (at Narvik 68°25'N, 17°33'E) to Abisko (68°21'N, 18°49'E).





**Fig. 4.** Ratios of alive and dead *Empetrum nigrum* shoots in plots of local sites that were exposed to a natural winter warming event during December 2007. Ratios were determined in visually damaged and non-damaged plots ( $n = 5$  each) at three different sites, as described in Bokhorst et al. (2009). NDVI pictures were taken only during 2010 with the Maxmax camera. Repeated measures ANOVA indicates a significant difference ( $P < 0.05$ ) in alive to dead shoot ratios between the damaged and non-damaged areas differences across all years (site:  $F_{1,4} = 9.5$ ,  $P < 0.05$ ; time:  $F_{2,8} = 0.1$ ,  $P = 0.74$ ; time  $\times$  site:  $F_{2,8} = 8.1$ ,  $P = 0.01$ ). Error bars are SE.



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### Vegetation recovery following extreme winter warming events in the sub-Arctic estimated using NDVI from remote sensing and handheld passive proximal sensors

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**Many thanks for your  
attention!**